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JOB SAMPLES AS TANK GUNNERY PERFORMANCE PREDICTORS

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ARI FIELD UNIT AT FORT KNOX, KENTUCKY

U. S. Army

Research Institute for the Behavioral and Social Sciences

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This research was conducted to develop and evaluate job samples as predictors of tank gunnery performance. In Phase I of the research two potentially useful job sample predictors were identified and validated. Phase II results provided cross-validation of these predictors. Subjects in Phases I & II consisted of recent Armor OSUT graduates. Approximately one-half the subjects in Phase III were administered the job sample tests during their eighth week of training while the remaining one-half were tested at the Fort Knox Reception Station, i.e., prior to training. Phase III results demonstrated that

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feedback had no effect on job sample-tank gunnery relationships; however, level of prior training did have an effect. Eight week personnel performed at a higher level than Reception Station personnel on most job sample tasks. Results suggest that the job samples evaluated here offer promise in predicting performance after initial training and may be adaptable for use with the operational unit assignment process.

Technical Report 473

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Technology for Increasing
Soldier Productivity

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FOREWORD

A major research area for the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) is developing and evaluating technology for increasing soldier productivity. The ARI Field Unit at Fort Knox, Kentucky, in its work unit area "individual readiness model and assessment" (Army Project 2Q762717A767), is concerned with improving the methods used to assign personnel to training and service in tank crew duty positions. The long-range program includes developing and validating predictor tests to improve assignment practices and lead to enchanced tank crew combat proficiency.

The research report here describes the development and initial evaluation of predictive job sample tests for assigning tank crewmen to the position of gunner based on objective measures of their aptitudes and performance. The research was designed in response to requests by the USA Armor Center (USAARMC) and the USA Armor School (USAARMS).

Joseph Zeidner

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Technical Director

JOB SAMPLES AS TANK GUNNERY PERFORMANCE PREDICTORS

BRIEF

Objective:

To develop and evaluate job samples as predictors of tank gunnery performance.

Procedure:

The research was conducted in three phases. In Phase I, three job samples were developed and evaluated. These tasks represented three major requirements of tank gunnery performance: 1) the requirement to properly track a target, 2) the requirement to sense the location of a fired round with respect to the target, and 3) the requirement to properly adjust the second round after a first round miss. Each of these requirements was tested with an appropriate simulator, yielding relatively objective performance measures. The criterion used to evaluate the proposed predictors consisted of a modified Table VI live-fire gunnery exercise.

Phase II research was designed to complement and expand upon Phase I research, using a larger sample. In Phase I, the task measures were obtained from research participants who were completing training as tank gunner/loaders. Thus, any relationships observed in Phase I may have been a function of the training received, rather than innate abilities or aptitudes. To determine whether the relationships observed in Phase I were a function of achievement or aptitude, Phase II research included 10 drivers who had recently completed (MOS 19E) driver training at Fort Knox, but had not been given extensive gunnery training.

In Phase III, the effect of two key variables, verbal feedback and level of prior training on job sample-tank gunnery relationships were evaluated. In addition, a new job sample, center-of-mass, was included in the evaluation. Research participants were 31 individuals from the Reception Station at Fort Knox and 57 individuals in their eighth week of Basic Armor Training (BAT at Fort Knox. Difference scores, a reflection of the amount of improvement over trials on the job sample tasks were evaluated as predictors of live-fire gunnery performance. Phase III live-fire gunnery performance was scored using sophisticated video playback techniques.

Findings:

Phase I resulted in identification of two potentially useful job sample predictors. These were diamond tracking and round sensing. Round adjustment was not correlated with gunnery performance. Phase II results replicated the

Phase I relationships of diamond tracking and round sensing to tank gunnery. In Phase III, feedback had no effect on job sample-tank gunnery relationships. However, level of prior training did have an effect, with BAT personnel performing at a higher level than Reception Station personnel on most job sample tasks.

Utilization of Findings:

The results from the three phases of research suggest that job samples seem to offer promise in predicting performance after formal training but prior to assignment to operational units. Future research efforts may be directed toward the use of job samples as performance predictors for personnel within operational units. Hands-on/job sample tasks may be developed which are useful in the selection of gunners and tank commanders to fill vacated slots in operational units.

JOB SAMPLES AS TANK GUNNERY PERFORMANCE PREDICTORS

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INTRODUCTION

Prediction of tank gunnery performance has been the focus of several recent research efforts (Greenstein and Hughes, 1977; Eaton, Bessemer, and Kristiansen, 1979). The majority of this research has utilized paper-and-pencil aptitude/achievement tests as predictors. In contrast, job samples -- "hands-on" prediction tests which comprise aspects of the required task considered crucial to successful job performance -- have seldom been measured.

The rationale supporting the past emphasis on paper-and-pencil testing is easily understood. These tests are relatively inexpensive to produce and administer. They are easily scored, easily standardized and quite portable. On the other hand, measurement of performance on job samples is more difficult. Job samples usually require the development and/or purchase of equipment on which to perform and instrumentation for measuring that performance. Such equipment and instrumentation is frequently neither inexpensive nor easily portable.

Despite the research emphasis they have received and their obvious practical advantages, paper-and-pencil tests have had only moderate success as predictors of tank gunnery performance. Test-performance zero order correlation coefficients greater than .35 are rare. Further, multiple regressions of test scores on gunnery performance infrequently exceed .50. Finally, predictor-performance relationships seldom cross-validate to new samples (Eaton, 1978; Eaton, Bessemer, and Kristiansen, 1979).

The limited research in which job samples have been evaluated have yielded numerous task-performance relationships in the range of .30 to .40 (Eaton, 1978; Gobel, Baum, and Hagin, 1971). These results provide hope for improved prediction of gunnery performance. For example, in predicting training outcomes for several Air Force programs, Hunter, Maurelli, and Thompson (1977) demonstrated that job sample measures did yield significant increments over traditional (AFOQT) paper-and-pencil tests. Although no cross-validation efforts have been undertaken using job samples in the tank gunnery context, such efforts have been conducted successfully in other areas.

Interest in job sample testing has gained impetus from the notion that paper-and-pencil measures reflect variance associated with cognitive test-taking skills whereas job sample measures are relatively free of such variance due to their "hands-on" nature. In addition, Hunter (1975) has concluded that these psychomotor measures are less susceptible to the influences of prior educational and cultural differences among examinees. Thus an individual possessing the necessary psychomotor aptitudes and skills for successful job performance, but lacking the verbal skills or education to perform well on a paper-and-pencil test, is given an equal opportunity. These facts may explain to some extent the improvement in performance prediction obtained with job samples. For these reasons, recent research efforts directed toward the prediction of tank gunnery performance have emphasized hands-on performance for both predictors and criteria (Greenstein and Hughes, 1977; Eaton, 1978; Eaton, et al, 1979).

Another advantage of job samples is their face validity (Gordon and Kleiman, 1976). By selecting an actual portion of the task as the performance predictor, many of the situational variables, which would not be present to the same degree in paper-and-pencil tasks, are present and operating in the job sample tasks. An indication of this is the increased level of motivation experienced by most examinees (Seegal and Bergman, 1975; and Gordon and Kleiman, 1976). Pruitt (1970) suggested that these motivational differences may be due to the individual's perception that he or she is actually working rather than taking a test.

When job sample and paper-and-pencil tests were compared with regard to their adverse impact on examinee attitudes, "both minority and majority examinees saw the job sample tests as significantly fairer, clearer, and more appropriate in difficulty level" (Schmidt, Greenthal, Hunter, Berner, and Seaton, 1977, p. 187). This finding coupled with the finding that there were no significant differences between minority and majority attitudes toward either test provides support for expanding research in the area of job sample performance testing.

In summary, the advantages accompanying the use of job sample tests include: 1) reducing response bias and faking compared to self reports of attitudes, beliefs and interests (Wernimont and Campbell, 1968), 2) minimizing the disadvantages for individuals who have limited education and/or low level verbal skills, and 3) providing the examinees with more realistic expectations about the job (Pruitt, 1970; O'Leary, 1973; and Farr, O'Leary and Bartlett, 1973). The latter of these advantages is of significant interest in light of research which has shown that realistic job previews can decrease the likelihood of subsequent voluntary resignations (Ilgen and Seeley, 1974).

Due to the limited success enjoyed by paper-and-pencil tests as gunnery performance predictors, the empirical and logical support for considering job samples as performance predictors, and the continuing need of the Army to predict who will perform well in tank gunnery, this research was designed to explore the potential of job samples as gunnery predictors.

In Phase I a variety of job samples, including tracking, sensing, and round adjustment were developed. These job samples were evaluated as potential predictors with recent tank gunner/loader graduates as research participants. In Phase II, the most predictive job samples from Phase I were re-evaluated to determine whether the relationships observed in the first phase would obtain with a second sample of tank gunner/loader participants. In addition, Phase II job sample performance was evaluated with a sample of research participants who were relatively unfamiliar with tank gunnery (tank driver trainees) to determine the effect of gunner/loader training on job sample performance. The information obtained was used to evaluate the extent to which job sample-gunnery performance relationships might be related to aptitude rather than achievement. In Phase III, issues concerning time of job sample test administration relative to stage of training and the effects of external feedback were addressed. Research participants included gunner/loader trainees tested in either feedback or no feedback situations prior to training and after eight weeks of training.

PHASE I

In this phase of the research, three job samples were chosen for evaluation. These represented three major requirements of tank gunnery performance: 1) the requirement to operate tank controls in order to properly track a target (tracking), 2) the requirement to sense the location of a fired round with respect to the target so as to be able to make a proper adjustment for a second round (sensing), and 3) the requirement to change the point of aim, based on the location of a first round with respect to the target, to achieve a second round hit (round adjustment). Each of these requirements was tested with an appropriate simulator, yielding relatively objective performance measures. It was hypothesized that performance on the three job sample tasks would be positively related to tank gunnery performance because the three tasks appeared to have a high degree of face and content validity.

METHOD

SAMPLE

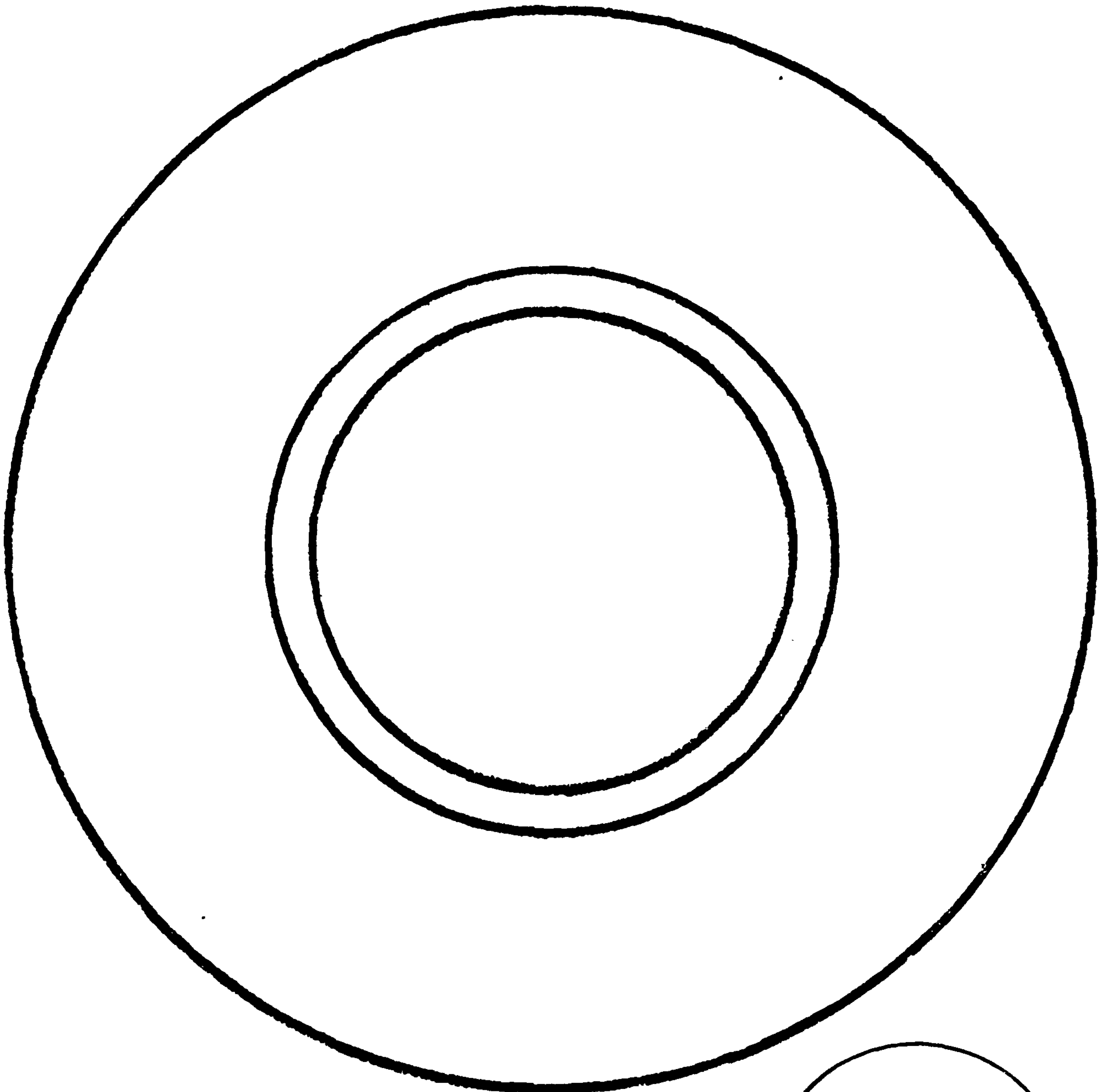
Research participants were 47 gunner/loaders. They were recent Armor OSUT (MOS 19E) graduates of Ft Knox for whom tank gunnery scores were available from ongoing research being conducted by the Army Research Institute Field Unit at Ft Knox. Not all personnel were tested on all tasks due to time constraints. Of the 47 gunner/loaders, 26 were tested on the tracking task, 31 were tested on the sensing task, and 16 were tested on the round adjustment task. Of these, 10 men participated on both tracking and sensing, 10 participated on both tracking and round adjustment, 15 participated in both sensing and round adjustment, and nine participated in all three tasks.

PROCEDURE AND VARIABLES

Crewmen participated in some or all of the job tasks described below. The three tasks were carried out in separate rooms, and scored by separate scorers.

Tracking Task. In the tracking task, gunner/loaders were given two geometrical designs, a circle and a diamond figure, to track using the Willey Burst-on-Target (BOT) trainer. The Willey BOT Trainer is a device designed to simulate tank gunnery engagements. The equipment basically simulates the M60A1 fire control system and includes a set of gunner's hand controls which modulate the position of the gunner's sight reticle with respect to the target. The actual size circle and diamond designs are shown in Figures 1 and 2 respectively. Reduced-to-scale inserts are also provided to demonstrate the visual field of the participant at the onset of tracking.

The task of each research participant was to track between the lines on each circle and diamond design a total of 20 times. Tracking direction (clockwise/counterclockwise) and design presentation (circle/diamond) were accomplished so that each crewman started on a different design than the crewman preceding him and research participants alternated directions of tracking for each trial.



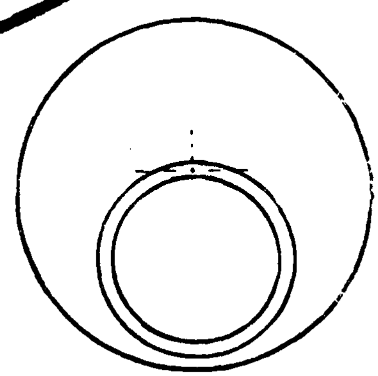


Figure 1. Circle Design. (Insert shows Willey BOT sight reticle in position for commencing the tracking task.)

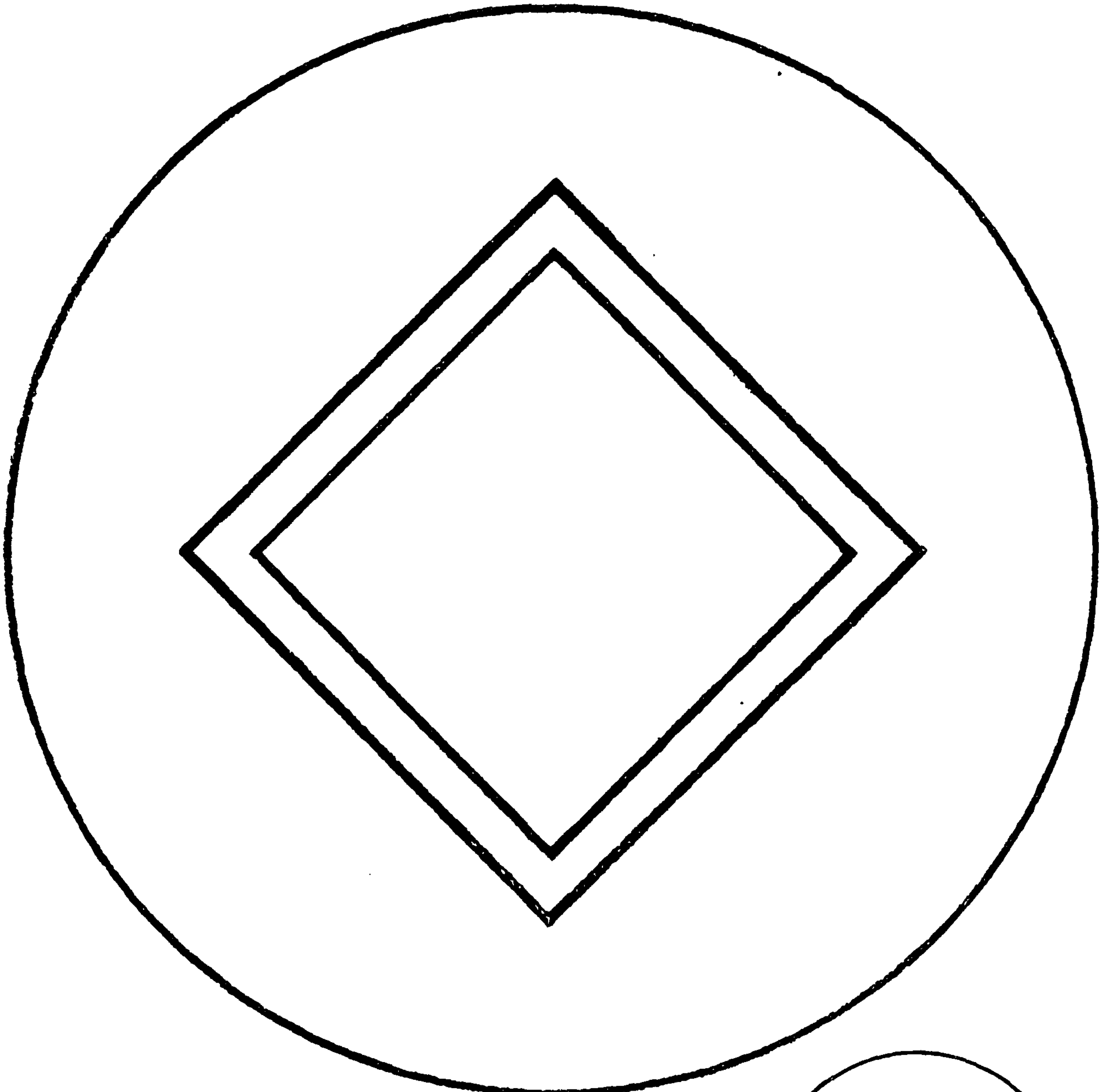
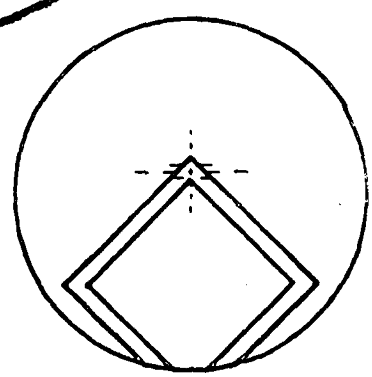


Figure 2. Diamond Design. (Insert shows Willey BOT sight reticle in position for commencing the tracking task.)



All crewmen received two scores for each of the 20 trials. The first score was a time score. Three scorers manually controlled separate 1/100 second Hunter timers. These timers recorded the time required to track the entire design. The research participant's score was the mean number of seconds appearing on the three clocks.

The second tracking score was an error score. This score was determined by the number of 0.5 sec periods that the sight reticle (aiming cross) on the Willey BOT trainer was either in contact with or outside the border line of the design. Scorers recorded the number of 0.5 sec pulses emitted by a Hunter timer during the time the sight reticle was not between the border lines of the design for each trial. The research participant's score for each trial was determined by averaging the error scores obtained from the three scorers.

Error and time scores for both diamond and circle were the means from the three scorers over trial 16-20 (the last five trials) for each crewman. Trials 16-20 were chosen because the asymptotic performance level was approached by trial 15, for both time and error.

Sensing Task. On the sensing task, 31 gunner/loaders reported their sensing of a total of 25 simulated main gun rounds. Five Ektachrome slides, each representing a different portion of a Table VI-M tank gunnery range at Ft Knox, Kentucky, were used to present targets for this task. Each crewman was required to sense the location of five simulated rounds "fired" at each of the five target slides. A typical slide is illustrated in Figure 3.

The "firing" simulation was accomplished by employing an ICONIX 6246 Tachistoscope (T-scope), two Kodak Carousel slide projectors, and a 50" X 36" screen. Each target slide was projected on the screen for the duration of a five-round simulated engagement. A second slide projector, controlled by the T-scope, presented a small red blip which was superimposed on the target projection slide for a period of 10 msec. The blip, simulating a main gun round, was produced by placing a red acetate film over a pinpoint hole made in a separate opaque slide.

The experimenter began the presentation for each of the 25 simulated rounds by announcing "on the way" and manually engaging the T-scope controlled sequence. After the presentation of each simulated round, the research participant recorded his sensing of the round on a score sheet which consisted of a hand-drawn replication of the Table VI-M target slide just presented. The participant received a new score sheet representing the new target slide prior to each five round engagement.

The deviation in millimeters of the sensed round from its true location was computed. These deviations were measured by placing a Xerographic transparency on which the true location of the simulated main gun rounds had previously been plotted over the participant's score sheet. The sensing score consisted of the mean deviation for the 25 trials.

Figure 3. Half-Tone Print of Sensing Slide.

Round Adjustment Task. The Fire Control Combat Simulator (FCCS) was used to measure the participant's round adjustment performance. The FCCS is a device designed to simulate tank gunnery engagements. The configuration and computer program simulated the M60A1 fire control system during conventional firing engagements. The FCCS contained an instructor's console and a gunner's station. From the instructor's console, a variety of situations could be programmed which specified target, terrain, and type of round, and required the gunner's assessment and response.

The task utilizing the FCCS tested crewmen on their ability to apply standard burst-on-target (BOT) procedures while tracking a moving target. BOT is a technique of fire adjustment employed when a first round miss occurs. The program of instruction at Ft Knox indicated that all gunners were trained to note the position of the miss relative to the sight reticle and place that portion of the sight reticle on the center of mass of the target.

By programming the FCCS in a particular sequence (see Appendix A), the gunner was forced to miss the first round. Each crewman was given six one-round practice engagements for familiarization with the apparatus. The practice engagements were not scored. At the conclusion of the practice, each crewman was given 12 two-round engagements that were scored. Scores for the crewmen were the number of targets "hit" on the second round of the 12 two-round engagements. The first round of each engagement was ignored because the first round was programmed to miss.

Tank Gunnery Scores: Table VI-M. Steel's Main Gun Tank Range at Ft Knox, Kentucky was used for the Table VI-M. Normal range operation procedures were utilized, but major changes were made in the targets, the engagements, and the method of scoring.

The standard cloth panel stationary targets were replaced by 1.8m x 1.8m stationary plywood targets. These targets were placed at ranges of 1000m and 1400m. The moving target was a 6.5m plywood flank tank target at a distance of 700m, traveling approximately 5 km/h and perpendicular to the line of fire. Standard zero panels placed at 1200m were also used.

Each crewman was required to fire a warm-up round at the zero panel, one two-round engagement at both the 1000m and 1400m targets, and two two-round engagements at the moving target. The order of fire and engagement techniques are shown in Appendix B.

Scoring was achieved by two scorers observing each firing tank. One scorer used a periscope, BC M65, 10x, while the other used a pair of 8x binoculars. Scorers also maintained constant voice contact with the firing tank through the use of the external intercom located at the rear of the M60A1 tank. Thus the scorers knew when the gunner would fire each round, and the specific target at which he was to fire. Scores were recorded as a hit or miss, based on a consensus between the two scorers.

Each research participant was required to do his own sensing, fire adjustment and firing. The function of the Tank Commander (TC) was to ensure that correct safety measures were followed, to determine the range to the target, to lay the gun tube in the general area of the target, and to give the fire command.

DATA HANDLING

Scores for time and error for both circle and diamond tracking were raw scores. In addition, combined scores for circle and diamond tracking were computed by converting each crewman's time and error scores (for each design separately) to $\underline{z}$ scores and adding the two scores together.

Scores on the sensing and round adjustment tasks were raw scores. On the sensing task, lost rounds or rounds sensed 25mm or more from their true location were scored as 25mm errors.

Tank gunnery (Table VI-M) performance measures were number of moving target hits, number of first round hits, and number of second round hits. Table VI-M overall scores were computed by multiplying the number of first round hits by 10 and adding that product to the number of second round hits multiplied by five.

RESULTS

TRACKING-TANK GUNNERY RELATIONSHIPS

Correlations were computed between each of the tracking task measures (time, error, and combined scores, for both circle and diamond figures) and each of the tank gunnery measures (overall scores, moving target hits, first round hits and second round hits). Although there were no significant relationships between <u>circle</u> tracking and tank gunnery performance, significant relationships were observed between <u>diamond</u> tracking and gunnery performance. Crewmen with fewer diamond errors had higher overall scores ($r = -.41$, $\underline{p} < .05$), and more first round target hits ($r = -.50$, $\underline{p} < .01$). A complete intercorrelation matrix is provided in Appendix C.

SENSING-TANK GUNNERY RELATIONSHIPS

Correlations were computed between participants' sensing scores and their gunnery measures (overall score, moving target hits, first round and second round hits). The relationship between sensing and both second round hits and overall scores approached significance ($r = -.35$ and $-.34$, $\underline{p} \approx .05$ and $.06$, respectively). It is interesting to note that although relationships with the tracking task were statistically significant, and those with the sensing task approached significance, the sensing and tracking tasks were not significantly correlated with one another (see Appendix C).

ROUND ADJUSTMENT-TANK GUNNERY RELATIONSHIPS

Analysis of the FCCS data and tank gunnery scores revealed no significant relationships. The ability to apply BOT procedures and hit a moving target on the FCCS device was not significantly related to the gunner's overall score, first and second round hits nor to the number of moving target hits (see Appendix C).

INTER-SCORER RELIABILITY ON TRACKING ERROR

Because the tracking error measure was based on the visual evaluation of research participant performance, the reliability of the tracking error could be questioned. Inter-scorer reliabilities were determined. The three scorers used in the tracking task provided high scorer reliability coefficients for diamond error and moderate reliability for circle error. For the diamond error measure, correlations were .91, .94, and .92 for scorers 1 and 2, 1 and 3, and 2 and 3, respectively. For the circle error measure, correlations were .63, .56, and .85 for scorers 1 and 2, 1 and 3, and 2 and 3, respectively.

DISCUSSION

The purpose of this research was to evaluate the relationship between performance on several job samples and tank gunnery performance. The results of the research revealed significant relationships between gunnery performance and both round sensing and tracking of the diamond figure. The fewer errors research participants made in sensing and tracking, the better they performed in tank gunnery.

The relationship between round sensing and measures of gunnery performance were readily interpretable. Round sensing had a numerically higher correlation with second round hits than with first round hits. Such a relationship was expected because applying BOT procedures involved knowing generally where the round landed with respect to the target (i.e., round sensing) and specifically where the sight reticle was placed with respect to the target picture. This provided the gunner with specific information on second round engagements, but only general information on first rounds of later engagements.

Relationships involving diamond tracking error were not so easily interpreted. The tracking task was designed to measure a participant's ability to operate the turret/gun controls. While such ability should have been generally related to performance on all engagements, it should have been most strongly related to moving target hits. However, that was not the case. Diamond tracking was significantly related only to first round hits, and overall score. Interestingly, the error, rather than the overall time measure, accounted for these relationships. Thus, it was not a gunner's overall speed on the tracking task, but instead his accuracy, that accounted for the variance in the gunnery performance.

Tracking the circle figure was much more difficult than the diamond. The circle required constant changes in horizontal and vertical movement (or

traverse and elevation), as opposed to the fixed degree of horizontal and vertical movement with changes only at corners required to track the diamond. However, the gunners in this research, were not required to perform such complex tracking on Table VI-M. The moving target traveled slowly across the range in a constant direction. This difference may have accounted for the failure to observe a relationship between circle tracking and moving target hits. Circle tracking may serve as a predictor of gunnery performance with evasive targets moving in complex patterns (see Jones and Jehan, 1978, for further discussion on this topic).

No clear rationale exists for the failure to observe predictor-criterion relationships between the circle tracking and overall gunnery performance. One explanation proposed that the lower scorer reliability for the circle error may have contributed to the lack of significant correlations.

The failure to observe relationships between the round adjustment measure and gunnery performance was also not easily interpreted. The round adjustment measure should have evaluated both tracking and BOT ability. Yet despite the high fidelity of the FCCS controls, and the objective measurement potential it offered, no significant results with gunnery were obtained. In fact, the highest correlation, a -.21, was in the wrong direction, i.e., the more targets hit on the FCCS, the fewer second round hits on Table VI-M. Apparently high-fidelity and sophisticated stimulus control and response measurement in a simulator are no guarantee of significant relationships with on the job performance.

PHASE II

Phase II of this research was designed to complement, and expand upon, the Phase I research. Overall, the results of Phase I research were favorable, and two job sample measures were related to gunnery performance (diamond error and sensing error). Several issues however, were not completely addressed.

First, because a small number of participants performed all tasks, the intercorrelations between tasks provided in Appendix C can only be considered as crude estimates of population parameters. These intercorrelations should be explored more fully to determine the degree to which task performance accounts for unique gunnery variance. Tasks related to gunnery performance, but unrelated to one another, account for unique gunnery variance, and thus may be combined for improved gunnery prediction. Those tasks which are highly intercorrelated, on the other hand, are redundant, that is, a second measure adds little to prediction, once the first measure is known.

In addition, during the first phase of the research, many different measures of the job sample tasks were obtained, and many measures of Table VI-M were evaluated, but the sample size was relatively small. Consequently, there was liberal opportunity for Type II errors in evaluating relationships between task measures and gunnery performance. Those tasks which did show apparently significant relationships with gunnery performance (tracking and sensing) needed to be re-evaluated to determine whether the task-gunnery relationships observed in Phase I were attributable to chance.

Finally, the task measures in Phase I were obtained from research participants who were completing training as tank gunner/loaders. Thus, the relationships observed may have been due to achievement rather than aptitude. Participants who received more help in training, had prior experience or worked harder, could have learned to be better gunner/loaders, and consequently performed better on both tank gunnery and the job sample tasks.

Such a hypothesis implies that for some of the gunner/loader participants at least, training, aptitude, and/or motivation resulted in some level of achievement, and that the achievement was reflected by task performance. Consequently, this hypothesis can be evaluated by comparison of task performance of gunner/loader trainees, and other participants who are comparable in many ways, but are relatively untrained in gunnery.

The purpose of the Phase II research was to address these issues by providing more stable measures of task intercorrelations, re-evaluating and validating the significant task-performance relationships observed in Phase I, and determining whether task-performance relationships are more likely due to achievement or aptitude measurement.

METHOD

SAMPLE

Research participants included 24 gunner/loaders who recently graduated from Armor OSUT (MOS 19E) at Ft Knox and for whom tank gunnery Table VI-M

scores were available. In addition, the sample included 10 drivers who recently completed Armor OSUT (MOS 19F) at Ft Knox. Unlike gunner/loaders, drivers are not given extensive gunnery training, and do not fire on main gun tank ranges at Ft Knox.

PROCEDURE

Tracking Task. As in Phase I, crewmen were given the circle and diamond designs to track on the Willey device. Each crewman was required to track both designs 20 times as in Phase I. Diamond and circle error scoring was accomplished the same way with the exception that only one scorer was used.

Sensing Task. The methods for the sensing task were the same as in Phase I with the exception that half-tone prints were used in place of the standard hand-drawn score sheets and lost rounds or rounds sensed 10mm or more from their true location were scored as 10mm errors. The half-tone prints were copied from the pictures of the Table VI-M course that were used for the target slides.

Round Adjustment Task. The round adjustment task was eliminated because no significant relationships with Table VI-M performance were observed in Phase I.

Table VI Modified. The Table VI-M firing range procedures and method of scoring were identical for Phases I and II. Table VI-M was fired by gunner/loaders only. Drivers did not fire Table VI-M as it was not part of their normal training, and not necessary for the research.

RESULTS

TANK GUNNERY RELATIONSHIPS

Tracking: Tank Gunnery Relationships. Correlations were computed between each of the tracking task measures and the tank gunnery measures. As in Phase I there were no significant relationships between circle tracking and tank gunnery performance, but significant relationships did exist between diamond tracking and tank gunnery performance. Gunner/loaders with fewer diamond errors had higher overall gunnery scores ($r = -.49$, $p < .02$), more moving target hits ($r = -.41$, $p < .05$), more first round hits ($r = -.43$, $p < .05$) and more second round hits ($r = -.46$, $p < .05$). A complete intercorrelation matrix is provided in Appendix D.

It is interesting to note that in Phase II crewmen tended to take longer in the tracking task and to make more errors than the crewmen in Phase I. Because both samples were drawn from the same population, there is some reason to believe that the higher error scores in Phase II were the result of scorer learning. The scorer in the tracking task probably became more skilled or proficient in the task of scoring. This result would indicate a need to refine the scoring technique and instrument the scoring phase whenever possible to control this scorer influence.

Sensing: Tank Gunnery Relationships. Correlations were computed between the sensing score and the tank gunnery measures. A significant relationship was observed between number of errors on the sensing task and tank gunnery performance. As can be observed in Appendix D, crewmen with fewer sensing errors had higher overall scores ($r = -.41$, $p < .05$). No significant relationships were observed between sensing score and the moving target, first round hits, or second round hits, although the correlations with moving targets and second round hits approached significance (r's $= -.36$ and $-.35$, $p < .10$). It is also worthy to note that the correlation between diamond error and sensing error was again nonsignificant (and in this case, zero).

Tracking and Sensing Combined: Tank Gunnery Relationships. Phase I research suggested the utility of both diamond error and sensing error as predictors of Table VI-M scores and indicated their intercorrelation was about zero. Therefore, both error scores for Phase II subjects were combined as predictors of Table VI-M according to the unit-weighted model (as suggested by Einhorn and Hogarth, 1975; Schmidt, 1971; and Lawshe and Schucker, 1959). Unit-weighted models have been suggested for small sample research because only the direction of the predictor-criterion relationship needs to be known. Beta weights are not computed, but instead are set arbitrarily at one. While there is somewhat less precision with this approach, there is also less opportunity for error in incorrect Beta-weight estimation.

In applying the unit-weighted model to the data, standardized scores were computed for tracking error, sensing error, and Table VI-M overall scores. Standardized error scores were then added together, and their sum correlated with standardized Table VI-M scores, yielding an $r = .64$, $p < .01$ (the signs for the error score were reversed to achieve a positive-going scale). Thus, the fewer errors a participant made in tracking and sensing the higher his predicted Table VI-M score, and the better his actual Table VI-M score. This relationship is shown in Figure 4.

In addition to computations with the unit weight model, standard multiple regression cross-validation techniques were employed. Beta weights for tracking and sensing error measures were computed from Phase I data and applied to standardized error scores in Phase II, yielding an $R = .65$, $p < .01$. The high similarity between unit model and multiple regression model results was due to the ratio of the computed Beta weights ($B_1 = -.64$, $B_2 = -.59$). Their ratio was .92, nearly 1.00. Consequently, in this case unit-weight and multiple regression models provided nearly the same result. The plot of multiple regression predicted to actual Table VI-M scores was almost identical to Figure 4.

Comparisons Between Gunner and Driver Performance. To evaluate the extent to which gunner's performance on the tracking and sensing tasks was a function of their prior gunnery training (i.e., achievement) in 19E Armor OSUT, comparisons of gunner's and driver's scores were made by using t-tests. Means, standard deviations, t-test results, and sample size are shown in Table 1 for drivers and gunners on each task. No significant differences between gunners and drivers were observed on any of the tasks. In the one instance where the comparison did suggest a difference between gunner and driver performance,

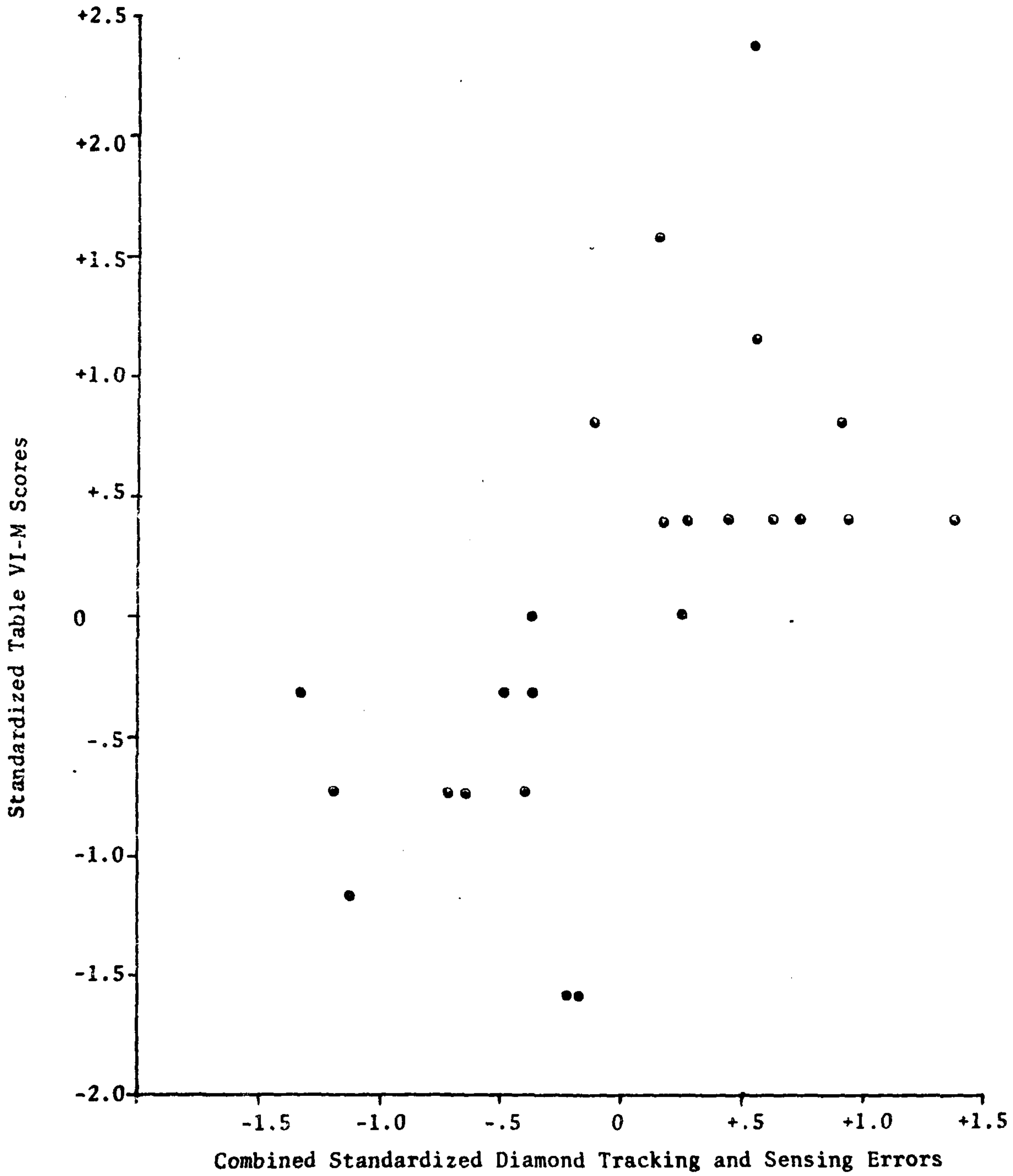


Figure 4. Prediction of Gunnery Performance from Combined Standardized Diamond Tracking and Sensing Errors Based on Unit Weight Model

Table 1

GUNNER AND DRIVER COMPARISONS

	Gunner (N = 24) Mean	Standard Deviation	Driver (N = 10) Mean	Standard Deviation	t*
Diamond Error	10.43	4.70	10.48	7.53	.02
Diamond Time	17.87	5.50	18.14	4.37	.12
Circle Error	14.01	6.07	16.44	2.37	-1.04
Circle Time	20.82	7.02	19.17	5.17	-.57
Sensing Error	39.88	11.77	28.96	18.61	-1.77

*all $p > .05$

sensing error, (t = -1.77) drivers yielded less error than gunners. This result is contrary to the direction hypothesized had the job sample-gunnery performance relationships been based on achievement.

DISCUSSION

The purpose of this phase of the research was to confirm and extend the findings of Phase I. The results confirmed both of the significant relationships between Table VI-M scores and diamond and sensing error. In addition, both a unit-weighted model and a standard multiple regression model, based on results from Phase I, provided a very good fit between Phase II diamond and sensing measures and Table VI-M performance. Approximately 35% of the variance on Table VI-M was accounted for by those two variables. The magnitude of this relationship was due to the fact that the two error measures proved to be uncorrelated, and thereby provided unique contributions to predictions of gunner's scores. In addition, the relationships between gunnery and job sample scores seem to be more likely due to aptitude rather than achievement measurement. This is because gunner/loaders, who had considerable gunnery training, scored no better on the job sample tasks than drivers, who had relatively little gunnery training.

Overall, it appears that the development and empirical validation of an appropriate set of job samples gives promise of measures yielding reasonably large correlations with gunnery performance. Moreover, such relationships may be attributed, in large part, to aptitude rather than achievement measurement. Consequently, such techniques seem to have reasonable potential for use in assignment of personnel to appropriate training programs.

PHASE III

Phase III of this research was conducted to further evaluate the use of job samples in predicting criterion performance. The results of the two previous phases prompted interest in the effects of two key variables, verbal feedback and level of training on the previously identified predictor/performance relationships.

Feedback has been shown to enhance learning. This effect has been demonstrated for individuals (Stockbridge and Chambers, 1958) and groups (Alexander, Kepner, and Tregoe, 1962) in military settings. Holding (1965) described a useful system for classifying information feedback (IF) or knowledge of results. Major dichotomies in this system include: 1) intrinsic (present in the standard task) versus artificial (added to the standard), 2) concurrent (during response) versus terminal (after response), and 3) separate (for each response) versus accumulated (for several responses). This system provides a useful framework in which to discuss the effects of varying the kind and the amount of feedback, both of which have been shown to affect performance (Goldstein and Rittenhouse, 1954).

A specific amount of feedback is intrinsic to both the job sample testing and the gunnery criterion performance situations. With regard to job sample testing, it was not known whether providing feedback enhanced or degraded performance on job sample tests. In addition, the effect of feedback on predictor/performance relationships had not been determined.

In the two previous phases, job samples were measured <u>after</u> formal armor training. Reasonably large correlations with subsequent gunnery performance were obtained. The question existed as to whether these correlations would obtain when job sample measurement took place before training, or after basic training, but before intensive gunner/loader training.

In addition to evaluating the effects of feedback and level of training, a new job sample task was included in Phase III. Center-of-mass determination represented a major component of tank gunnery performance which included the requirement to traverse the turret and lay the main gun quickly and accurately on the preferred portion of the target.

Finally, job samples as predictors of tank gunnery performance had not previously been compared to current ASVAB based paper-and-pencil predictors. This required obtaining job samples, ASVAB, and gunnery performance data for a large sample of research participants.

METHOD

SAMPLE

The research participants were randomly selected from the population of trainees assigned to gunner/loader (MOS 19E) training at Ft Knox. Job sample tests were administered to 160 men representing 10 separate companies. Not

all personnel were tested on all tasks due to time constraints and all the men from one company were eliminated from the data analysis due to equipment performance failure beyond the control of the experimenter. Of the remaining 144 participants, complete data sets were available for 63 or 88, depending upon the analysis required.

PROCEDURE

Sixteen (16) men per company from 10 companies were tested. Eight of the 16 men from each company were tested during the time they were in the Ft Knox Reception Station. The remaining eight were tested after they had completed approximately eight weeks of Basic Armor Training (BAT). Of the eight persons in each of these groups, four received verbal feedback (knowledge of results) during the job sample testing, while the remaining four received no verbal information concerning their performance. Each participant was tested on three separate job sample tasks: 1) tracking, 2) sensing, and 3) center-of-mass.

Tracking Task. Crewmen were asked to track the diamond design using the Willey BOT trainer. After receiving appropriate instructions, (see Appendix E) each crewman was allowed to practice tracking the design once clockwise and once counterclockwise. Upon completion of the practice trials, each crewman tracked the design 20 times, alternating direction at the beginning of each trial. Crewmen in the feedback group were provided with scores reflecting the time it took them to track the design and the number of errors committed after each trial. Crewmen in the no feedback group were not provided information concerning their performance.

The time score consisted of the total elapsed time from the "go" command to the "stop" command on each trial. This score was the time appearing on a standard 1/100 second Hunter timer which was manually controlled by the scorer. The total number of errors per trial was computed by counting the number of 0.5 sec pulses emitted by another Hunter timer during the time in which the aiming cross portion of the sight reticle was not between the borders of the diamond design. Scorers viewed the design by means of a video monitor placed on a table behind the subject. For convenience the pulses from the second Hunter timer were recorded on cassette tape and played through headphones worn by the scorer, thereby minimizing subject distraction. The tracking trials were videotaped for later error score verification.

Sensing Task. The methods for the sensing task were the same as in Phase II with the exception that crewmen in the feedback group were told their mean deviation for the five rounds in each engagement prior to the presentation of the next target slide (see Appendix F). In the no feedback group, no information was provided concerning performance.

Center-of-Mass Task. This task was presented immediately following completion of the tracking task and was videotaped in its entirety. A slide presenting four tanks was placed in the Willey BOT. The crewman was instructed to move the aiming cross from the center position (see Figure 5) to the designated target on the command "go" (see Appendix G). The crewman fired the

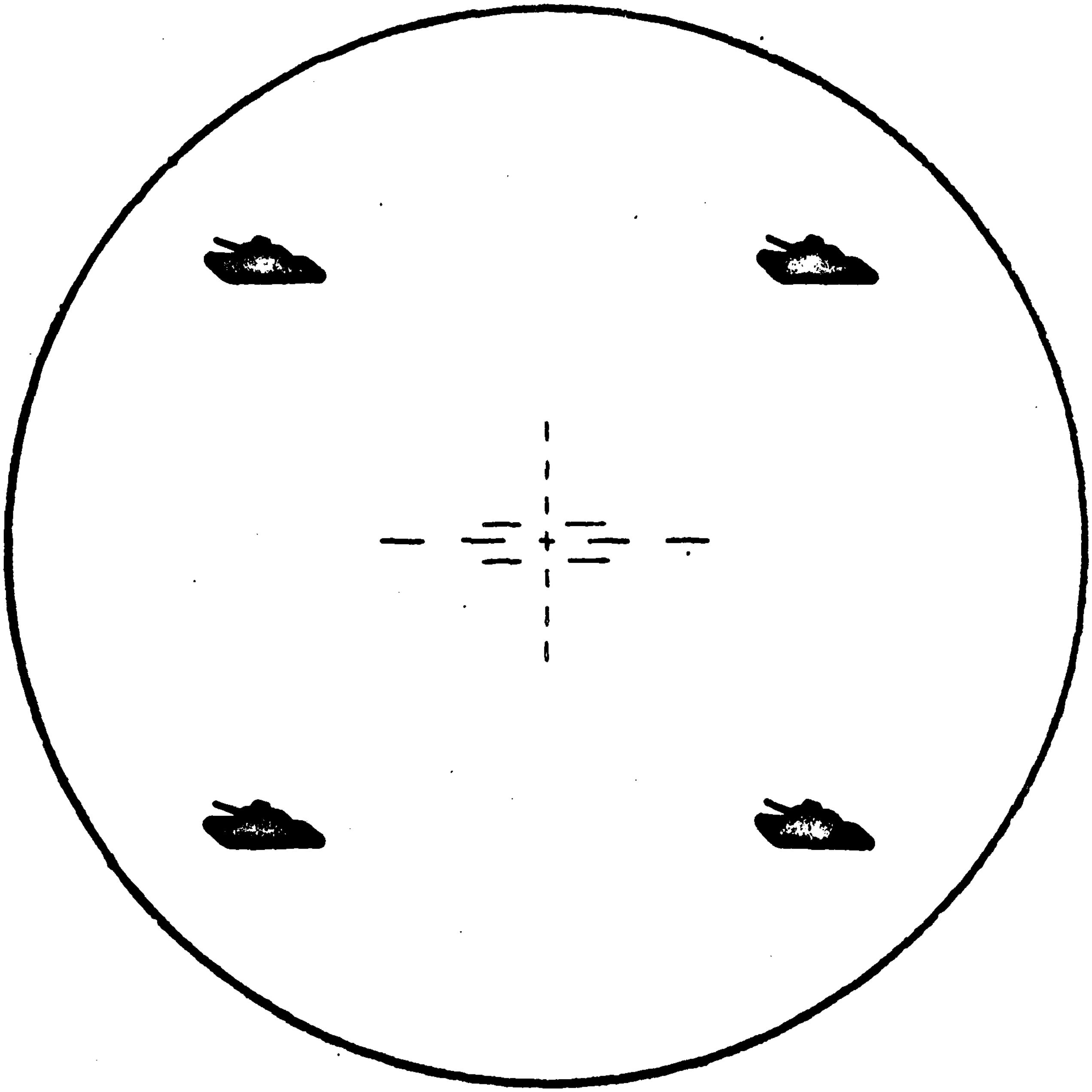


Figure 5. Target Design for Center-of-Mass Task with Sight Reticle in Starting Position.

Willey laser when he determined that the aiming cross was on the center-of-mass of the target. Each participant completed eight trials, two trials per target.

Scoring was accomplished by means of a manually controlled Hunter stop-clock to determine total time for each trial from the "go" command until firing. A 1.5 square millimeter transparent grid was placed over the instructor's viewing screen of the Willey and displayed on a video monitor behind the subject. This allowed the scorer to accurately determine the deviation of the aiming cross from the true center-of-mass.

Crewmen in the feedback group were informed as to their time to center-of-mass and amount of deviation from true center after each trial. Crewmen in the no feedback group were not provided information concerning their performance.

ASVAB. Scores for each participant on seven Armed Services Vocational Aptitude Battery (ASVAB) subtests were obtained from personnel records. These were Word Knowledge (WK), Mathematics Knowledge (MK), Mechanical Comprehension (MC), Numerical Operations (NO), Arithmetic Reasoning (AR), Electronics Information (EI), Automotive Information (AI) and Classification Inventory-Electronics (CE). These subtests were chosen based on previous research (Eaton, Bessemer, and Kristiansen, 1979) which developed two paper-and-pencil predictors of tank crewman performance. Table 2 shows how these subtest scores were combined and what predictor criterion relationships have previously been obtained (Maitland, Eaton, and Neff, 1980).

Table VI-M. The Table VI-M order of firing and engagement techniques used in Phase III were the same as in Phases I and II with the exception that crewmen were not required to fire a warm-up round at the zero panel. Scoring procedures, however, were different. Each engagement was videotaped for subsequent verification on a 21" video screen. Two cameras were used, one recorded stationary engagements at 1000m and 1400m by means of a 1000mm telescopic f = 5.6 lens, the other recorded the moving engagements at 700m using a 500mm telescopic f = 5.6 lens. The cameras were situated approximately 25m to the left or right of the firing tank. The direction selected offered the least amount of obscuration during firing from smoke, dust, or heat distortion, etc. The video tapes were played at a later date for scoring by two experimenters (see Appendix H for sample score sheet). The playback equipment allowed a frame-by-frame analysis that could easily detect rounds passing through holes produced by previous rounds.

DATA HANDLING

Tracking Data. The tracking task was quantified to yield six separate measurements of tracking performance for each participant. Three were related to tracking time and three to tracking error. These measures were obtained by computing: 1) the mean error and time scores for the first four trials, 2) the mean error and time scores for the last four trials (i.e., trials 17 through 20), and 3) the difference between means for time and the difference between means for error.

Table 2

ARMED SERVICES VOCATIONAL APTITUDE BATTERY (ASVAB) BASED ARMOR

CREWMEMBER SELECTION TESTS

Predictor Tests	Combined Standardized Subtest Scores*	Correlation with Criterion**
Gunnery UMO	Word Knowledge (WK) Mathematics Knowledge (MK) Mechanical Comprehension (MC)	.29***
Driving UMO	Numerical Operations (NO) Arithmetic Reasoning (AR) Electronics Information (EI) Automotive Information (AI) Classification Inventory-Electronics (CE)	.40***

*Formulae from Eaton, Bessemer and Kristiansen (1979)

**Correlations from Maitland, Eaton, and Neff (1980)

***$p < .001$

Sensing Data. The data obtained from the sensing task was quantified, as in Phase II, by computing the mean number of errors for the 25 trials completed by the participants.

Center-of-Mass Data. Four measures were obtained from the center-of-mass task: 1) the mean time for trials five through eight, 2) the difference between the time means for trials one through four and five through eight, 3) the mean number of errors for trials five through eight, and 4) the difference between error means for trials one through four and five through eight.

ASVAB Data. Raw scores for three of the seven ASVAB subtests were summed to yield a predictor called the Gunnery UMS. These subtests were WK, MK, and MC (see Table 2). The raw scores for the remaining four subtests were summed to form another predictor referred to as Driving UMS. These subtests were NO, AR, EI, AI, and CE (see Table 2). Gunnery UMS and Driving UMS were summed to provide a third predictor. In addition, the three raw scores used to obtain the Gunnery UMS were converted to standard scores with a mean of 100 and a standard deviation of 15, then summed to yield a fourth predictor referred to as the Gunnery UMO (Eaton, Bessemer and Kristiansen, 1979). The use of the UMS and UMO notation is based upon formulae presented in Maitland, Eaton, and Neff (1980). UMO refers to unit-weighted models that contain only standardized ASVAB subtests. UMS refers to unit-weighted models containing only raw scores from ASVAB subtests.

Table VI-M Data. Tank gunnery (Table VI-M) performance measures included number of moving target hits, number of first round hits, number of second round hits, and number of total hits. These scores were converted to z scores on a company by company basis because no two companies fired the same tank on the same day.

RESULTS

JOB SAMPLE RELATIONSHIPS

A two-way multivariate analysis of variance (MANOVA) was performed to determine if level of prior training had a significant effect on the performance of four job sample tasks. Results of this analysis revealed a significant difference between the task performance of Reception Station (no prior training) and BAT (eight weeks of training) personnel ($F = 28.76$; $p < .0001$). Post-hoc univariate analyses for tracking error, sensing error, and center-of-mass error revealed a significant level of training main effect $F = 27.126$; $p < .0001$; $F = 39.295$; $p < .001$; and $F = 42.883$; $p < .0001$, respectively for the three tasks. There was no difference between Reception Station and BAT personnel for the center-of-mass (COM) time job sample task. As can be seen in Table 3, BAT personnel, on the average, performed better on job sample tasks, i.e., made fewer errors) or were faster than the Reception Station personnel. The exceptions to this were that BAT personnel in both the feedback and no feedback groups made more errors on the sensing task and the BAT personnel in the feedback group took longer to locate the center-of-mass than did the Reception Station personnel.

To determine whether or not the Reception Station personnel differed from BAT personnel in tank gunnery performance, *t* - tests were performed. No difference was found between the two groups for total hits, moving target hits, first round hits, or second round hits.

The second factor, in the two-way MANOVA was type of feedback (i.e., presence or absence of feedback). The results of this analysis revealed no difference in job sample task performance between individuals who received information concerning their performance and those who did not, for any of the four tasks. Neither was there an interaction between level of training and type of feedback. To determine whether the feedback and no feedback groups could be collapsed under their respective levels of training, tests of colinearity were performed (Kirk, 1968, p. 471). None were significant. Therefore, because there were no differences found between means and the hypothesis that the overall regression line was linear could not be rejected, the distinction between the feedback and no feedback groups within levels of training in subsequent analysis was not retained.

TANK GUNNERY RELATIONSHIPS

All participants for whom complete job sample and gunnery data sets were available (31 Reception Station and 57 BAT) were included in subsequent analyses.

Tracking: Tank Gunnery Relationships. Correlations were computed between each of the six tracking task measures and three of the tank gunnery measures (total hits, first round and moving hits) for both Reception Station and BAT level personnel. A significant relationship was observed between mean tracking time (trials 17 through 20) and number of moving target hits for the Reception Station personnel ($r = .32$; $p < .05$). Faster tracking times were associated with more moving target hits.

For BAT level personnel, four significant tracking task-tank gunnery relationships were observed. Significant relationships were observed between the difference score for tracking time and both first round and total number of hits ($r = .26$; $p < .05$ and $r = .31$; $p < .05$). Significant relationships were also observed between the difference score for tracking error and both first round and total number of hits ($r = .24$; $p < .05$ and $r = .25$; $p < .05$). A complete inter-correlation matrix for both Reception Station and BAT level personnel is provided in Appendix I.

Sensing: Tank Gunnery Relationships. Correlations were computed between mean number of sensing errors and two tank gunnery measures (second round hits and total hits) for both Reception Station and BAT level personnel. Contrary to the findings in Phases I and II with OSUT graduates, sensing was not found to be related to tank gunnery performance.

Center-of-Mass: Tank Gunnery Relationships. Correlations were computed between four separate measures of center-of-mass task performance and two measures of tank gunnery performance (first round hits and total hits). No significant relationships were observed

ASVAB. Tank Gunnery Relationships. All participants for whom complete job sample, ASVAB, and gunnery data sets were available (30 Reception Station

Table 3

MEANS AND STANDARD DEVIATIONS FOR RECEPTION STATION AND BAT PERSONNEL FOR FOUR JOB SAMPLE TASKS*

	Reception Station								BAT							
	Tracking		Sensing		COM Time		COM Error		Tracking		Sensing		COM Time		COM Error	
	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD
Feedback	18.96	15.05	4.10	1.13	6.03	3.81	1.65	.72	9.20	4.87	5.28	1.50	6.14	2.57	.87	.50
No Feedback	22.46	16.14	3.78	1.11	5.99	2.94	1.74	.86	11.54	8.37	5.41	1.33	5.76	2.20	.99	.61

*Values obtained from 2-way MANOVA

and 33 BAT) were included in subsequent analyses. None of the four ASVAB derived measures, Gunnery UMS, Gunnery UMO, Driving UMS, nor Gunnery plus Driving UMS, was related to total number of Table VI hits. Complete correlation matrices are provided in Appendices J and K.

DISCUSSION

The purpose of this research was to determine the effects of two variables, type of feedback and level of prior training, on job sample task performance and on job sample-tank gunnery relationships. The results of Phase III testing revealed no difference on job sample performance for participants receiving feedback versus those who did not. This lack of difference may be accounted for by the concurrent intrinsic feedback present in the selected job sample tasks. For example, the gunner's controls on the Willey BOT trainer modulated the position of the sight reticle relevant to the target while the eyepiece allowed him to obtain constant information concerning the effect his responses had on the position of that reticle. In the sensing task, participants were provided feedback, not after each round, but after each five round engagement. This meant that they were given information concerning their performance on a given target slide just prior to commencing a new five-round engagement on a new target slide. Thus the participants may not have had the opportunity to apply the information they received within the specific context in which it would have been most profitable *i.e., on the original target slide). Future research efforts should closely evaluate the time of feedback (e.g., immediate, delayed, etc.), the form of feedback (e.g., millimeters, number of errors, lapse time, etc.), and the quantity of feedback relative to the capacity of the capacity of the participant to process information in the allotted time.

Significant differences were revealed in Phase III between personnel with no prior training and personnel in their eighth week of Basic Armor Training on three job sample tasks. However, no difference in job sample task performance was found for participants in the feedback and no feedback groups. Several of the relationships between job sample measures and tank gunnery performance found in Phases I and II of this research did not obtain in Phase III when personnel who had no hands-on gunnery experience served as research participants. However, one new measure method, difference scores, did show promise. Finally, no relationship was found between ASVAB based gunnery predictors and performance of gunners in their first live firing experience.

Phase I and II research participants were recent Armor OSUT (MOS 19E) graduates who were tested on job sample tasks at the end of their 13th week of training just prior to their first live firing experience. However, Phase III participants had no formal gunnery training or very little prior to job sample testing. The finding of significant differences between the two groups in Phase III on job sample tasks most likely reflects the fact that job sample scores are quantifying components of performance which are affected by experience. Thus, contrary to the suggestion made based on Phase II results, previous methods of quantification must necessarily be measures of achievement rather than aptitude. For this reason, a new method of quantifying job sample performance which took into account prior experience or training was evaluated. This method relied upon the use of difference scores.

The Phase III attempt to quantify "improvement" and remove initial proficiency level from the measure, by the use of difference scores, provided some degree of promise at the BAT level. Because difference scores may reveal the amount of improvement over trials, the significant positive correlations which were obtained indicate that the greater the improvement the greater the number of first round hits and the higher the total number of hits. Thus, difference scores, in a rather crude form are measures of the "ability to learn." It is this ability to learn which is often referred to as aptitude. To find measures which are predictive of future performance but are not severely affected by training, one must first identify aptitudes Methodology must then be developed to appropriately measure these aptitudes. Future research must concentrate on determining the most suitable methods for quantifying the job samples that have already been identified as critical "aptitude-containing" components of specific tasks.

The failure of the ASVAB based paper-and-pencil predictors to cross-validate to new samples came as no surprise and served to provide continued support for the Eaton, Bessemer, and Kristiansen (1979) proposal that research efforts should be directed toward job sample and simulator techniques for predicting gunnery performance.

SUMMARY AND CONCLUSIONS

The research reported herein was designed to evaluate several job sample predictors' gunnery performance. In the first phase of the research a variety of job sample measures were evaluated. These included several measures of tracking, sensing, and round adjustment tasks. Tracking a diamond figure and round sensing were both related to gunnery performance. The fewer errors a gunner/loader made on these tasks, the better he fired the tank main gun.

Job sample measures which were related to gunnery performance in the first phase of the research, were re-evaluated with a new sample of research participants in the second phase of the research. In addition, a unit-weighted prediction model and a standard regression model, based on Phase I results, were applied to Phase II results, accounting for approximately 35% of gunnery variance. Moreover, comparison of job sample scores of personnel who were either given extensive training (e.g., gunner/loaders), or little training in gunnery (e.g., drivers), was interpreted as suggesting that the observed relationships were best attributable to measurement of aptitude rather than achievement level. Consequently, the job sample technique was described as holding promise as an assignment tool for personnel entering gunnery training programs.

However, in the third phase of research, when previously evaluated job samples were re-evaluated with participants from the Reception Station (i.e., individuals having no prior gunnery training) and from eighth week of BAT (Basic Armor Training), a detrimental effect on the previously identified job sample -- tank gunnery relationships was noted Thus the emphasis change from what could be referred to as concurrent research to predictive research seemed to have a degrading effect on job sample relationships. The suggestion from Phase II that the job sample tasks, as measured, reflected aptitude rather than achievement had to be reconsidered. As a result the method of quantifying job sample tests was changed to reflect improvement in performance over time rather than absolute level of performance, and many of the relationships were once again observable -- at least for BAT level personnel.

The critical aspect of job samples as tank gunnery performance predictors appears to be the methods used to quantify task performance. These methods must account for prior experience (i.e., training) and accurately reflect the individual's potential for acquiring the necessary skills.

Job samples and associated simulation techniques show excellent promise as predictors of tank gunnery performance. Future research must place an emphasis on the aptitude measurement methodology used to quantify both the job sample tasks and the performance criteria.

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APPENDICES:

APPENDIX A

SEQUENCE OF CONSOLE SETTINGS FOR FCCS ENGAGEMENT SIMULATIONS

APPENDIX A

SEQUENCE OF CONSOLE SETTINGS FOR FCCS ENGAGEMENT SIMULATIONS

1. Sabot, L, 1000m
2. Heat, L, 1000m
3. Sabot, R, 1000m
4. Hep, L, 1000m
5. Heat, R, 1000m
6. Hep, R, 1000m

1. Sabot, L, 2500m, Start Range, Stop, 1500m, Start
2. Heat, Start
3. Sabot, R, 1000m, Start, Range, Stop, 1500m, Start
4. Heat, Start

5. Heat, L, 2500m, Start, Range, Stop, 1500m, Start
6. Sabot, Start
7. Heat, R, 1000m, Start, Range, Stop, 1500m, Start
8. Sabot, Start

9. Sabot, R, 1000m, Start, Range, Stop, 1500m, Start
10. Heat, Start
11. Heat, L, 2500m, Start, Range, Stop, 1500m, Start
12. Sabot, Start

APPENDIX B

TABLE VI-M

TABLE VI-M

Engagement	Target	Range in meters	Engagement Technique	Ammunition
1	Zero panel	1200	Precision Periscope	HEAT
2	Stationary panel	1000	Precision Telescope	HEAT
3	Moving tank silhouette	700	Battlesight-Periscope	HEAT
4	Stationary panel	1400	Precision Periscope	SABOT
5	Moving tank silhouette	700	Precision Telescope	HEAT

APPENDIX C

PHASE I MEANS, STANDARD DEVIATIONS AND INTERCORRELATION MATRIX

PHASE I MEANS, STANDARD DEVIATIONS, AND INTERCORRELATION MATRIX

	Diamond Error	Diamond Time	Diamond Combined	Circle Error	Circle Time	Circle Combined	Sensing Error	Round Adjustment	Moving Target Hits	1st Round Hits	2nd Round Hits	Table VI
Diamond Error												
Diamond Time	.31 (26)											
Diamond Combined	-.81*** (26)	.80*** (26)										
Circle Error	.29 (26)	.78*** (26)	-.65*** (26)									
Circle Time	-.15 (26)	.78*** (26)	-.38* (26)	.74*** (26)								
Circle Combined	-.08 (26)	-.84*** (26)	.55*** (26)	-.93*** (26)	.93*** (26)							
Sensing Error	-.39 (10)	.40 (10)	.24 (10)	.36 (10)	.57* (10)	.57* (10)						
Round Adjustment	.18 (10)	-.29 (10)	.20 (10)	-.50 (10)	-.15 (10)	.45 (10)	-.11 (15)					
Moving Target Hits	.26 (26)	-.18 (26)	.06 (26)	.11 (26)	.21 (26)	-.18 (26)	.09 (31)	.13 (16)				
1st Round Hits	-.50*** (26)	-.04 (26)	.34* (26)	-.06 (26)	.08 (26)	-.01 (26)	-.29 (31)	.13 (16)	.66*** (32)			
2nd Round Hits	.18 (26)	.05 (26)	.15 (26)	.07 (26)	.08 (26)	-.08 (26)	-.35* (31)	-.21 (16)	.63*** (32)	.38** (32)		
Table VI Score	-.41** (26)	.07 (26)	.30 (26)	.03 (26)	.09 (26)	-.06 (26)	-.34* (31)	.01 (16)	.72*** (32)	.90*** (32)	.69*** (32)	
$\bar{X}$	6.56	13.32	-.04	10.91	15.67	-.0015	43.24	2.19	2.22	1.34	1.75	23.72
SD	2.19	4.42	1.62	3.19	6.27	1.86	14.34	1.87	1.43	.97	1.02	12.87
N	26	26	26	26	26	26	31	16	32	32	32	47

* $p < .10$, two-tailed
** $p < .05$, two-tailed
*** $p < .01$, two-tailed

APPENDIX D

PHASE II MEANS, STANDARD DEVIATIONS AND INTERCORRELATION MATRIX (N=24)

PHASE II MEANS, STANDARD DEVIATIONS, AND INTERCORRELATION MATRIX (N=24)

	Diamond Error	Diamond Time	Diamond Combined	Circle Error	Circle Time	Circle Combined	Sensing Error	Moving Target Hits	1st Round Hits	2nd Round Hits	Table VI
Diamond Error											
Diamond Time	.05										
Diamond Combined	76***	.67***									
Circle Error	.43**	.20	.44**								
Circle Time	.10	.52***	.39	.65***							
Circle Combined	29	.45**	.48***	.83***	.88***						
Sensing Error	.06	.09	.02	.09	.13	.10					
Moving Target Hits	-.41**	.16	-.21	.06	.18	.14	-.36*				
1st Round Hits	-.43**	.15	-.22	-.06	.04	.001	-.33	.73***			
2nd Round Hits	-.46**	.16	-.43**	-.16	-.23	-.18	-.35*	.72***	.53***		
Table VI	-.49***	.03	-.35*	-.16	-.12	-.13	-.41**	.80***	.91***	.81***	
$\bar{X}$	10.43	17.87	1.66	14.01	20.82	.17	39.88	1.96	1.29	1.50	20.00
SD	4.70	5.02	46	6.07	7.02	1.83	11.77	1.20	.86	1.18	12.68

*p < .10, two-tailed
**p < .05, two-tailed
***p < .02, two-tailed

APPENDIX E

PHASE III TRACKING TASK INSTRUCTIONS

PHASE III TRACKING TASK INSTRUCTIONS

At this station you will participate in a tracking task. You will use this equipment to perform the tracking task.

1. These are hand controls (point).

2. This is the palm switch on each side (point).

3. The hand control works only when the palm switch is depressed (show) (move + to center).

4. Put both hands on the controls, look through the eyepiece here, and depress the palm switch.

5. Turn the hand control to the right to make the crosshair appear to move to the right; -- do it now. (HELP IF NEEDED.)

6. Turn the hand control to the left to make the crosshair appear to move to the left; -- do it now. (HELP IF NEEDED.)

7. Rotate the hand control back to make the crosshair appear to move up; -- do it now. (HELP IF NEEDED.)

8. Rotate the hand control forward to make it go down; -- do it now. (HELP IF NEEDED.)

9. To go on the diagonal, up and left, turn the control to the left, and rotate backward; -- do it now.

10. To go down and right, turn the control to the right, and rotate forward; -- do it now.

11. Go back to the center.

12. To go down and left, turn left, and rotate forward; -- do it now.

13. To go up and right, turn right and rotate backward; -- do it now.

14. The more you turn the controls in one direction, the faster the crosshair moves.

You are to track this diamond design (indicate) by keeping these (indicate) cross-hairs in between the two lines (indicate). You will start from here (the top) when I say "go" and track in the direction I indicate. When you get back to the top I will say "stop." You will be scored on how fast you track the design and how many errors you make. An error is scored when the center of the cross-hair touches the black lines or goes outside the black lines. Now I will give you 2 trials to practice. (Show the man how to track the design -- once to the left and once to the right -- and then allow the man two minutes of practice).

Now we are going to score your next 20 trials.

Feedback Only: At the end of each trial I will tell you how long it took you to track the design and how many errors you made.

APPENDIX F

PHASE III SENSING TASK INSTRUCTIONS

PHASE III SENSING TASK INSTRUCTIONS .

"At this station you will participate in a sensing task. The purpose of this task is to determine if you can locate a flash of light on this screen." At this point the T-scope was opened until the participant identified the simulated round. He did not record his sensing of the round. Once he was sure of the location of the round, the cycle was started to close the T-scope. Then the researcher continued to read the instructions. "That is what it will look like, but it will only appear for a brief moment, like this." The start button on the T-scope was pressed, at this point, to allow for a simulated round flash to occur. The researcher would point to the approximate location of the flash to facilitate the participant's sensing of the flash. This would be repeated as many times as necessary to insure that the participant could see the flash. He did not record his sensing of the round. Then the researcher returned the target slide projector to the first target slide and continued to read the instructions. "There will be one flash at a time and I will announce "on the way" prior to each flash. I have given you five pictures, one for each of the slides you will see. For each slide there will be five flashes on or near a target that I indicate. Your task is to locate the flash on the slide and place a dot in the same spot on the picture. In addition you will place a number beside the dot to indicate which flash in the sequence you just recorded. I will tell you the number to record." This was done prior to giving the "on the way", i.e., "number one on the way". "If you are unable to see the flash write "lost" and the "number" in the top-right hand corner of your picture."

Feedback Only: "At the end of each five round sequence I will score your paper and tell you how many millimeters your recorded flash is from the true location."

APPENDIX G

PHASE III CENTER-OF-MASS TASK INSTRUCTIONS

PHASE III CENTER-OF-MASS TASK INSTRUCTIONS

"In this task, you will be required to move the cross-hairs from the center dot (identify) to the target I designate, and place the cross-hairs in the center of that target. Do this as quickly as you can. You will start on my command "go". When you have the cross-hairs on the center of the target, stop moving the hand control, and fire, as I do now." (Scorer, stop the clock at this point.) "After you "stop," fire a three to four round burst and then move the cross-hairs back to the center dot. You will be given eight trials and each will be videotaped. Do not fire "on the move"!"

Feedback Group Only: "At the end of each trial you will be told how long it took you to locate the center and fire, and the number of units you were off the center."

"Are there any questions?"

Scorer Instructions

Have the man locate the center-of-mass for the targets in this order: 1st-top left target; bottom right target; 3d-top right target; 4th-lower left target.

Record total time from "go" to "fire."

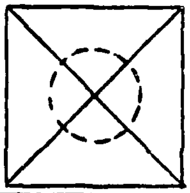
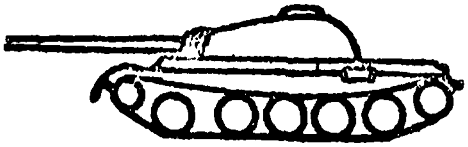
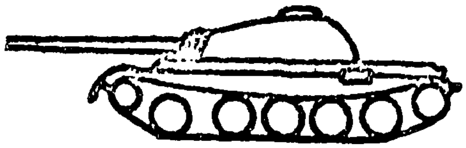
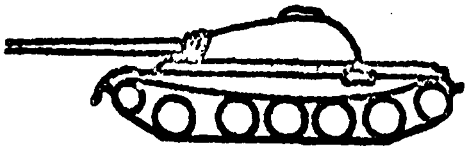
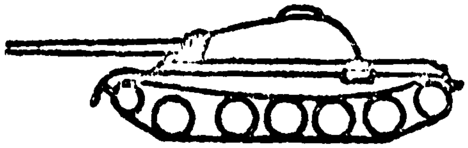
APPENDIX H

TABLE VI TANK GUNNERY SCORE SHEET

TABLE VI TANK GUNNERY SCORESHEET

GUNNER NAME________________ SCORER NAME________________

DATE______________ WEATHER____________ TANK______________

TARGET (RANGE)	SIGHT TO BE USED (AMMO)
1. ZERO PANEL (1200m) 	PERISCOPE (HEAT)
2. STATIONARY TANK (1000m) Rd 1 H M	TELESCOPE (HEAT) Rd 2 H M
3. MOVING TANK (BATTLESIGHT) Rd 1 H M 	PERISCOPE (HEAT) Rd 2 H M 
4. STATIONARY TANK (1400m) Rd 1 H M	PERISCOPE (SABOT) Rd 2 H M
5. MOVING TANK (700m) Rd 1 H M 	TELESCOPE (HEAT) Rd 2 H M 
First Round Hits 0 1 2 3 4 5	Second Round Hits 0 1 2 3 4 5
Total Number of Hits ________	Verified by Hole Count? YES________ NO________

APPENDIX I

PHASE III MEANS, STANDARD DEVIATIONS

AND INTERCORRELATION MATRIX FOR RECEPTION STATION (N=31)

AND BAT PERSONNEL (N=57)

PHASE III MEANS, STANDARD DEVIATIONS, AND INTERCORRELATION MATRIX FOR RECEPTION STATION (N=31) AND BAT PERSONNEL (N=57)

	Tracking Time $\bar{X}$ 1-4	Tracking Time $\bar{X}$ 17-20	Tracking Time Diff. Score	Tracking Error $\bar{X}$ 1-4	Tracking Error $\bar{X}$ 17-20	Tracking Error Diff. Score	Sensing Error $\bar{X}$ 1-25	COM Time $\bar{X}$ 5-8	COM Time Diff. Score	COM Error $\bar{X}$ 5-8	COM Error Diff. Score
Tracking Time $\bar{X}$ 1-4											
Tracking Time $\bar{X}$ 17-20	.56(.75)†										
Tracking Time Diff. Score	.95(.73)	.30(.09)									
Tracking Error $\bar{X}$ 1-4	.95(.68)	.44(.55)	.94(.46)								
Tracking Error $\bar{X}$ 17-20	.67(.50)	.87(.68)	.47(.05)	.61(.78)							
Tracking Error Diff. Score	.85(.32)	.15(-.14)	.93(.63)	.93(.41)	.31(-.24)						
Sensing Error $\bar{X}$ 1-25	.64(-.24)	.23(-.20)	.65(-.15)	.71(-.15)	.36(-.06)	.70(-.14)					
COM Time $\bar{X}$ 5-8	.56(.33)	.50(.33)	.47(.16)	.55(.37)	.62(.35)	.39(.06)	.39(-.09)				
COM Time Diff. Score	.16(.13)	.17(.25)	.10(-.06)	.05(.06)	.12(.10)	.01(-.05)	.01(.21)	-.08(-.53)			
COM Error $\bar{X}$ 5-8	.21(.03)	.13(.16)	.20(-.12)	.31(.06)	.17(.20)	.30(-.20)	.34(.02)	-.17(-.07)	.00(.11)		
COM Error Diff. Score	-.21(-.19)	.06(-.21)	-.27(-.06)	-.28(.02)	.01(-.01)	-.34(.05)	.35(.15)	.06(-.09)	-.23(.02)	.59(-.39)	
Moving Target Hits	.03(-.02)	.31*(-.18)	.08(.15)	.05(-.11)	.20(-.16)	.15(.03)	—	-.05(-.12)	.00(-.03)	.19(-.10)	-.02(.10)
1st Round Hits	.12(.10)	.05(-.10)	-.12(.26*)	-.11(.03)	-.06(-.13)	-.11(.24*)	—	.00(-.05)	-.09(-.03)	.25(-.07)	.10(.19)
2d Round Hits	—	—	—	—	—	—	.11(.08)	—	—	—	—
Total Hits	.13(.10)	.21(-.17)	-.08(.32*)	-.11(-.02)	.17(-.20)	-.06(.25*)	.26(.08)	-.05(-.12)	.00(-.03)	-.19(-.10)	-.02(.10)
$\bar{X}$	37.07(17.01)	18.69(12.89)	18.37(4.11)	40.78(12.74)	18.73(10.36)	22.04(2.37)	3.98(5.50)	5.65(5.94)	2.18(.39)	1.77(.96)	-.06(-.03)
SD	34.73(7.26)	10.33(5.01)	30.11(4.84)	40.20(7.53)	14.49(7.08)	33.26(4.84)	1.25(1.37)	2.70(2.37)	2.31(1.74)	.82(.60)	.80(.72)

†RECEPTION STATION (BAT)
*p<.05 one-tailed

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APPENDIX J

PHASE III MEANS, STANDARD DEVIATIONS

AND INTERCORRELATION MATRIX FOR RECEPTION

STATION PERSONNEL (N=30)

PHASE III MEANS, STANDARD DEVIATIONS, AND INTERCORRELATION MATRIX FOR RECEPTION STATION PERSONNEL (N=30)

	Tracking Time $\bar{X}$ 1-4	Tracking Time $\bar{X}$ 17-20	Tracking Time Diff. Score	Tracking Error $\bar{X}$ 1-4	Tracking Error $\bar{X}$ 17-20	Tracking Error Diff. Score	Sensing Error $\bar{X}$ 1-25	COM Time $\bar{X}$ 5-8	COM Time Diff. Score	COM Error $\bar{X}$ 5-8	COM Error Diff. Score	Gunnery UMS	Gunnery UMO	Driving UMS	Gunnery + Driving UMS	Total Hits
Tracking Time $\bar{X}$ 1-4																
Tracking Time $\bar{X}$ 17-20	.56															
Tracking Time Diff. Score	.96	.30														
Tracking Error $\bar{X}$ 1-4	.95	.44	.94													
Tracking Error $\bar{X}$ 17-20	.67	.87	.67	.62												
Tracking Error Diff. Score	.85	.15	.93	.94	.31											
Sensing Error $\bar{X}$ 1-25	.64	.23	.65	.72	.36	.71										
COM Time $\bar{X}$ 5-8	.56	.52	.47	.55	.62	.39	.38									
COM Time Diff. Score	.11	.12	.09	.03	.11	-.01	.04	-.12								
COM Error $\bar{X}$ 5-8	.18	.07	.18	.28	.16	.27	.36	-.22	.05							
COM Error Diff. Score	-.17	.14	.24	-.25	.06	-.37	-.38	.35	-.26	-.59						
Gunnery UMS	-.16	-.02	-.13	-.15	-.15	-.10	.02	-.38	-.00	.40	-.38					
Gunnery UMO	-.23	-.03	-.25	-.22	-.22	-.17	-.04	-.40	.12	.36	-.35	.96				
Driving UMS	-.26	-.09	-.24	-.23	-.28	-.15	-.07	-.43	.02	.40	-.41	.89	.91			
Gunnery + Driving UMS	-.21	-.06	.22	-.20	.15	-.14	-.04	-.43	.02	.40	-.41	.96	.95	.98		
Total Hits	-.09	-.15	.04	-.08	-.16	-.03	-.27	-.06	-.11	-.25	-.10	-.24	-.22	-.11	-.17	
$\bar{X}$	[illegible]	[illegible]	[illegible]	42.20	[illegible]	23.18	3.93	3.84	[illegible]	[illegible]	-.11	38.67	498.13	72.37	110.77	[illegible]
SD	35.16	[illegible]	30.47	40.58	14.72	33.57	1.28	2.72	2.44	.85	.78	9.63	32.90	14.34	23.58	.94

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APPENDIX K

PHASE III MEANS, STANDARD DEVIATIONS, AND

INTERCORRELATION MATRIX FOR BAT PERSONNEL (N=33)

PHASE III MEANS, STANDARD DEVIATIONS, AND INTERCORRELATION MATRIX FOR BAT PERSONNEL (N=33)

	Tracking Time $\bar{X}$ 1-4	Tracking Time $\bar{X}$ 17-20	Tracking Time Diff. Score	Tracking Error $\bar{X}$ 1-4	Tracking Error $\bar{X}$ 17-20	Tracking Error Diff. Score	Sensing Error $\bar{X}$ 1-25	COM Time $\bar{X}$ 5-8	COM Time Diff. Score	COM Error $\bar{X}$ 5-8	COM Error Diff. Score	Gunnery UMS	Gunnery UMO	Driving UMS	Gunnery + Driving UMS	Total Hits
Tracking Time $\bar{X}$ 1-4	—															
Tracking Time $\bar{X}$ 17-20	.74															
Tracking Time Diff. Score	.71	.05														
Tracking Error $\bar{X}$ 1-4	.70	.62	.38													
Tracking Error $\bar{X}$ 17-20	.57	.78	.02	.82												
Tracking Error Diff. Score	.35	-.11	.64	.49	-.09											
Sensing Error $\bar{X}$ 1-25	-.27	-.19	-.20	-.21	-.17	-.12										
COM Time $\bar{X}$ 5-8	.19	.27	.00	.28	.36	-.07	-.25									
COM Time Diff. Score	.09	.30	-.18	.12	.16	-.04	.31	-.62								
COM Error $\bar{X}$ 5-8	-.01	.18	-.21	.01	.30	-.43	-.01	-.12	.27							
COM Error Diff. Score	-.15	-.19	-.01	.10	.01	.16	.22	-.03	.00	-.30						
Gunnery UMS	-.41	-.41	-.18	-.26	-.33	.05	.13	-.16	-.04	-.19	.04					
Gunnery UMO	-.41	-.33	-.26	-.23	-.25	-.02	.17	-.12	.01	-.10	.02	.97				
Driving UMS	-.42	-.29	-.32	-.15	-.10	-.10	-.01	-.10	-.04	-.00	.09	.80	.84			
Gunnery + Driving UMS	-.44	-.35	-.28	-.20	-.20	-.04	.04	-.13	-.03	-.05	.08	.92	.94	.97		
Total Hits	.03	-.20	.26	-.11	-.28	.25	.21	-.29	-.03	-.10	-.06	.14	.14	.12	.14	
$\bar{X}$	18.29	13.54	4.75	14.55	11.43	3.12	5.20	6.11	.23	.97	-.07	35.45	492.73	74.88	110.52	-.05
SD	7.90	5.59	5.34	8.31	7.27	4.72	1.45	2.38	1.86	.61	.76	12.36	60.46	18.96	29.87	.91

1 US ARMY WESTERN COMMAND, ATTN: APE
1 HQDA, ATTN: DAAG-ED
1 HQ, TCATA, ATTN: ATCAT-OP-Q
2 HQDA, RESEARCH AND STUDIES OFC
1 MILITARY OCCUPATIONAL DEVELOPMENT DIV, DAPC-MSP-O, RM 852C,
HOFFMAN BLDG I
4 OASD (MRA AND L)
1 HQ TCATA TECHNICAL LIBRARY
1 HQDA, ODCSPER
1 HQDA, ATTN: DAMI-ISI
1 USA AVIATION SYSTEMS COMD, ATTN: DRSAV-ZDR
1 USA CORADCOM, ATTN: AMSEL-PA-RH
1 USA ARRADCOM, ATTN: ATFE-LO-AC
1 HEADQUARTERS, US MARINE CORPS, ATTN: CODE MPMT
1 HEADQUARTERS, US MARINE CORPS, ATTN: CODE MPI-20
2 US ARMY EUROPE AND SEVENTH ARMY
1 1ST INFANTRY DIVISION AND FT. RILEY, ATTN: AFZN-DPT-T
1 USA INTELLIGENCE AND SECURITY COMMAND, ATTN: IAOPS-TNG-T
2 HQ TRADOC TECHNICAL LIBRARY
1 NAVAL TRAINING EQUIPMENT CEN, ATTN: TECHNICAL LIBRARY
1 MILITARY OCCUPATIONAL DEVELOPMENT DIRECTORATE, ATTN: ATZI-
NCR-MS-M, RM 3N33, HOFFMAN BLDG II
1 DATA ANALYSIS DIVISION, ATTN: ATZI-NCR-MD, HOFFMAN BLDG II
1 USA MILPERCEN, ATTN: DAPC-POO-T
1 8TH INFANTRY DIVISION
1 HQDA, ARMY FORCE MODERNIZATION COORDINATION OFFICE
1 HQDA, ATTN: DASG-PTB
1 NAVAL AIR SYSTEM COMMAND
1 124D USARCOM RESERVE CENTER
1 US ARMY SOLDIER SUPPORT CENTER, ATTN: ATSG-HDD (DR. CAVINESS)
1 USA FORCES COMMAND AFLG - DEPUTY CHIEF OF STAFF FOR LOGISTICS
1 DIRECTORATE OF TRAINING, ATTN: ATZQ-T
1 DIRECTORATE OF COMBAT DEVELOPMENTS, ATTN: ATZQ-D
1 HQDARCOM MARINE CORPS LIAISON OFC
1 DEPARTMENT OF THE ARMY US ARMY INTELLIGENCE + SECURITY COMMAND
1 USA MISSILE COMMAND, ATTN: DRSMI-NTN
1 ARTADS, ATTN: DRCPM-TDS-TD
1 USA FORCES COMMAND
1 PM TRADE
1 US MILITARY DISTRICT OF WASHINGTON OFC OF EQUAL OPPORTUNITY
1 NAVAL CIVILIAN PERSONNEL COMD SOUTHERN FLD DIV
20 ARI LIAISON OFFICE
1 7TH ARMY TRAINING COMMAND
1 HQDA, DCSOPS UNIT TRAINING
1 HQDA, DCSOPS TRAINING DIRECTORATE
1 HQDA, DCSLOG MAINTENANCE MANAGEMENT
1 HQDA, DCS STUDY OFFICE
1 US NAVY TRAINING ANALYSIS EVALUATION GROUP
1 USACDEC, ATTN: ATEC-EX-E, HUMAN FACTORS
1 ATTN: SM-ALC/DPCR
1 INTER-UNIV SEMINAR ON ARMED FORCES + SOC
1 OASA (RDA) DEPUTY FOR SCIENCE AND TECHNOLOGY
1 OFC OF NAVAL RESEARCH
1 AFHRL/LRT
1 AFHRL/LRLG
1 AIR FORCE HUMAN RESOURCES LAB, ATTN: AFHRL/TSR
1 AFAMRL/BB
1 NAVY PERSONNEL R AND D CENTER DIRECTOR OF PROGRAMS
1 NAVY PERSONNEL R AND D CENTER
2 OFC OF NAVAL RESEARCH PERSONNEL AND TRAINING RESEARCH PROGRAMS
1 NAVAL PERSONNEL R + D CENTER
1 OFC OF NAVAL RESEARCH PROJECT OFFICER, ENVIRONMENTAL PHYSIOLOGY
1 OFC OF NAVAL RSCH ORGANIZATIONAL EFFECTIVENESS PRO.
1 NAVAL AEROSPACE MEDICAL RSCH LAB, AIRBORNE RANGER RESEARCH
1 DEPT. OF NATIONAL DEFENSE, DEFENSE AND CIVIL INSTITUTE OF
ENVIR MED
1 NAVAL AEROSPACE MEDICAL RSCH LAB, AEROSPACE PSYCHOLOGY DEPARTMENT
1 USA TRADOC SYSTEMS ANALYSIS ACTIVITY, ATTN: ATAA-TCA
1 HEADQUARTERS, COAST GUARD, CHIEF, PSYCHOLOGICAL RSCH BR
1 USA RESEARCH AND TECHNOLOGY LAB, ATTN: DAVDL-AS (DR. R. S. DUNN)
1 USA ENGINEER TOPOGRAPHIC LABS, ATTN: ETL-GSL
1 USA MOBILITY EQUIPMENT R AND D COMD, ATTN: DRDME-TQ (SCHOOL)
1 NIGHT VISION LAB, ATTN: DRSEL-NV-SDD
1 USA TRAINING BOARD, ATTN: ATTG-ATB-TA
1 USA HUMAN ENGINEERING LAB
1 USA MATERIEL SYSTEMS ANALYSIS ACTIVITY, ATTN: DRXSY-C
1 BATTELLE-COLUMBUS LABORATORIES, TACTICAL TECHNICAL OFC
1 USA ARCTIC TEST CEN, ATTN: AMSTE-PL-TS
1 USA COLD REGIONS TEST CEN, ATTN: STECR-OP
1 USA CONCEPTS ANALYSIS AGCY, ATTN: CSCA-RQP
1 USA CONCEPTS ANALYSIS AGCY, ATTN: CSCA-JF
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